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GROWTH OF THE HUMAN PITUITARY FOSSA

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INTRODUCTION

FOR a number of years the Brush and Bolton Foundations carried on in Cleveland a very extensive research program on the growth and development of healthy children. While assisting in this work I noted striking variations in the size and shape of the pituitary fossa as seen on lateral roentgenograms of the skull. A survey of the literature revealed that considerable work had been done on this area but no findings based on a longterm longitudinal study had been reported. Pancoast *et al* ('40), in their textbook *Head and Neck in Roentgen Diagnosis,* state, "There have been too few measurements below the age of six years for accurate statistics." No extensive investigations of fetal material were found with the exception of the work of Covell. Various workers have reported on skeletal collections, but Pruett's study is the only one based on a documented collection.

The present investigation, based on the well documented collections of the Department of Anatomy, Western Reserve University, and of the Brush and Bolton Foundations, makes it possible to follow the growth of the sella turcica from the fifth fetal month to old age. The age, sex, race, and physical proportions and measurements of each in-

dividual are known. In the dead, the cause of death as obtained from the death certificate is a matter of record and in many cases a considerable knowledge of health as obtained from clinical histories is available. In the living, very extensive data of health and of physical and mental development exist.

TABLE 1

Number of individuals studied, and number of examinations made

GROUP	NUMBER OF INDIVIDUALS	NUMBER OF EXAMINATIONS
Fetal skulls	418	418
White children	400	5 291
Negro children	391	483
Adult skulls	1 131	1 131
Total	2 340	7 323

Table 1 is a summary of the number of individuals studied and of the number of examinations made.

The material falls into four groups: measurements of fetal skulls, a longitudinal study of healthy white children, a cross-sectional study of healthy Negro children, and a report on the dimensions in adult skulls. The findings will be presented under these four headings.

GROWTH OF THE PITUITARY FOSSA DURING FETAL LIFE

From the collection of fetal skulls of the Department of Anatomy a total of 418 fetuses remained after those displaying obvious gross developmental defects were rejected, as were small fetuses whose sex was questionable and those in whom race appeared doubtful. Race was determined from the death certificate, and sex by direct observation. Many, if not all, of the Negro fetuses had some racial admixture.

Table 2 is a summary of measurements obtained from the fetal material. The condition of the skulls was such that satisfactory determination of vertical depth and transverse diameter of the pituitary fossa was not feasible. The horizontal length is the greatest anteroposterior

TABLE 2

Summary of measurements of fetal material

CROWNRUMP LENGTH (in mm.)	SEX	COLOR	NUMBER OF CASES	LENGTH OF PITUITARY FOSSA (in mm.)	RANGE (in mm.)
159 or less	M	W	14	3.06	2.0 5.0
	F	W	9	3.31	2.0 5.1
	M	N	7	3.33	2.0 4.4
	F	N	8	3.21	2.5 3.6
			Total 38	Av. 3.20	
160 to 209	M	W	22	4.15	2.8 5.3
	F	W	17	4.06	3.3 6.0
	M	N	5	4.24	3.6 5.0
	F	N	11	4.07	2.6 5.4
			Total 55	Av. 4.11	
210 to 249	M	W	27	4.25	3.2 5.8
	F	W	8	4.27	3.1 5.2
	M	N	11	4.30	3.5 5.3
	F	N	15	4.41	2.9 5.6
			Total 61	Av. 4.30	
250 to 279	M	W	26	4.50	3.2 5.8
	F	W	18	4.66	4.0 6.0
	M	N	10	4.61	3.8 5.3
	F	N	6	4.65	3.0 6.0
			Total 60	Av. 4.58	
280 to 339	M	W	42	4.90	3.5 7.0
	F	W	29	4.85	3.8 5.8
	M	N	18	5.09	3.2 6.9
	F	N	27	4.99	4.0 6.3
			Total 116	Av. 4.94	
340 or more	M	W	39	5.28	3.8 7.4
	F	W	24	5.21	3.7 5.9
	M	N	15	5.67	4.0 7.0
	F	N	10	5.78	3.3 7.7
			Total 88	Av. 5.38	
			418		

dimension and was made by direct measurement after the contents of the fossa had been removed.

TABLE 3

Observed and calculated values of the diameters of the hypophyseal fossa in fetuses ranging in total body length from 20 to 55 cm.
Reproduced from Covell ('27).

MEAN CROWN HEEL LENGTH (in cm.)	NUMBER OF CASES	TRANSVERSE DIAMETER		ANTEROPOSTERIOR DIAMETER		VERTICAL DIAMETER	
		Observed cm.	Calculated cm.	Observed cm.	Calculated cm.	Observed cm.	Calculated cm.
23.46	5	0.526	0.500	0.380	0.380	0.200	0.200
27.73	3	0.533	0.563	0.373	0.405	0.187	0.214
32.89	10	0.640	0.639	0.467	0.435	0.258	0.232
37.67	8	0.693	0.711	0.457	0.464	0.235	0.248
41.68	5	0.735	0.769	0.476	0.487	0.248	0.262
47.35	12	0.875	0.853	0.486	0.521	0.280	0.281
53.08	7	0.990	0.938	0.622	0.555	0.341	0.301

An examination of the measurements reveals that the pituitary fossa increases in length at a fairly steady and rather rapid rate during the last twenty-four weeks of the fetal period. There is no variation in rate of growth due to sex. In the oldest group, those having a crown-rump length of 340 millimeters or more, the anteroposterior length of the pituitary fossa of Negro fetuses is more than that of the white and there is a tendency for this measurement to be greater in the Negro at earlier ages. This is suggestive of a racial difference, particularly in view of the findings which will be presented in later parts of this report.

There is a marked variation in shape and a great range in length. There is no constant relation between size and shape of the sella and the length of the fetus. There are instances of a long fossa in a small fetus, and of a small fossa in a large baby. Many of the fossae are quite shallow.

Covell ('27) reported on the growth of the human prenatal hypophysis and hypophyseal fossa in a group of Caucasian fetuses. Table 3 is reproduced from his paper. He states that the hypophyseal fossa

TABLE 4

Relation of age and length in the human embryo
From Arey ('45).

AGE OF EMBRYO	CROWNRUMP LENGTH (in mm.)	CROWNHEEL LENGTH (in mm.)
Fifth lunar month	160.0	239.0
Sixth lunar month	203.0	296.0
Seventh lunar month	242.0	355.0
Eighth lunar month	277.0	409.0
Ninth lunar month	313.0	458.0
Full term (266 days)	350.0	500.0

is usually larger transversely than in the other diameters and the anteroposterior diameter is second in size, while the vertical diameter is the least of the three. His specimens were grouped on a basis of crownheel length, and in Table 4, taken from Arey's textbook on developmental anatomy ('45), the relationship between crownheel and crownrump length at various ages is shown. In Dr. Covell's series

and in mine the number of specimens in each group is not great, and an individual fetus is arbitrarily assigned to a group upon the basis of length. When these facts are taken into consideration, there is satisfactory agreement between the findings of the two investigations.

At term, the average anteroposterior length of the pituitary fossa is a little more than 5 millimeters. The Negro term child tends to have a slightly longer fossa than the white.

GROWTH OF THE PITUITARY FOSSA IN LIVING WHITE CHILDREN FROM THE AGE OF THREE MONTHS TO TWENTY-ONE YEARS

Over 4000 children have been examined by the Brush and Bolton Foundations. From this large collection a group of 100 white girls was selected who were first examined at the age of three months and who have been followed subsequently for a number of years. A group of 100 white boys was likewise selected who have been seen regularly for a long period, but only 93 of these had their first examination at three months. These children were normal in so far as every method used could determine. The parents were healthy and the children progressed satisfactorily in growth, maturation, and psychological development. They were examined at the age of three months, six months, nine months, one year, then at six-month intervals until the fifth birthday and thereafter at yearly intervals. Many of these children have been followed in the Bolton study for fourteen years.

In order to carry this portion of the study to adult life, it was necessary to select another group of 100 healthy children of each sex. The age at the first examination of these children varied from the seventh birthday to the twelfth. Many have been followed on the Bolton study for fourteen consecutive years.

As a part of the Bolton study of dentofacial development, lateral roentgenograms of the skull are taken in accordance with the Broadbent-Bolton technic ('31). By this method the shadow of the pituitary fossa as projected on the lateral film is not distorted nor altered to any appreciable degree. Cadaver skulls x-rayed by this method show identical measurements for the shadow and for direct anthropometry of the pituitary fossa. It is possible, therefore, to use the findings based on roentgenograms of the living for comparison with the findings of the fetal growth recorded in the previous section.

The measurements of the white males who were first examined in infancy have been combined with the findings of the preadolescent group in Table 5. The two groups of girls have been combined in Table 6.

TABLE 5

Growth of the pituitary fossa in male white individuals from the age of three months to twenty-one years

AGE	NUMBER OF INDIVIDUALS	AVERAGE LENGTH OF PITUITARY FOSSA (in mm.)	RANGE		AVERAGE DEPTH OF PITUITARY FOSSA (in mm.)	RANGE	
3 mos.	93	6.16	4.5	8.5	4.32	3.0	5.5
6 mos.	96	6.97	3.0	9.0	4.85	3.0	7.0
9 mos.	94	7.57	4.0	10.0	5.16	4.0	7.5
1 yr.	94	7.86	5.0	10.0	5.41	4.0	8.0
18 mos.	92	8.01	5.0	11.0	5.72	4.5	8.0
2 yrs.	94	8.31	6.0	12.0	5.93	4.5	8.0
30 mos.	91	8.49	6.0	13.0	6.13	4.5	8.5
3 yrs.	93	8.57	6.0	13.0	6.22	4.5	8.5
42 mos.	93	8.75	6.5	13.0	6.45	5.0	8.5
4 yrs.	95	8.84	7.0	13.5	6.58	5.0	8.5
54 mos.	88	8.98	7.0	13.5	6.66	5.0	9.0
5 yrs.	94	9.03	7.0	13.5	6.74	5.0	9.0
6 yrs.	91	9.21	7.0	13.5	6.88	5.0	9.0
7 yrs.	103	9.22	6.5	13.5	6.90	5.0	9.0
8 yrs.	105	9.26	6.5	13.5	6.95	5.0	9.0
9 yrs.	112	9.27	7.0	13.5	6.97	5.0	9.0
10 yrs.	139	9.29	7.0	13.5	6.98	5.0	9.0
11 yrs.	126	9.41	7.0	14.0	6.99	5.0	10.0
12 yrs.	140	9.54	6.0	14.0	7.00	5.0	10.0
13 yrs.	129	9.68	7.0	14.0	7.03	5.0	10.0
14 yrs.	108	9.90	7.0	13.0	7.05	5.0	10.0
15 yrs.	100	10.14	7.0	13.0	7.10	5.0	10.0
16 yrs.	98	10.23	7.0	13.0	7.20	5.0	10.0
17 yrs.	86	10.49	7.0	13.0	7.23	5.0	10.0
18 yrs.	71	10.62	7.0	13.0	7.32	5.0	11.0
19 yrs.	30	10.63	9.0	13.0	7.37	6.0	9.0
20 yrs.	13	10.70	9.0	12.0	7.39	6.0	9.0
21 yrs.	7	11.00	10.0	12.0	7.43	6.0	8.0

Total examinations 2575
Total individuals 200

TABLE 6

Growth of the pituitary fossa in female white individuals from the age of three months to twenty-one years

AGE	NUMBER OF INDIVIDUALS	AVERAGE LENGTH OF PITUITARY FOSSA (in mm.)	RANGE		AVERAGE DEPTH OF PITUITARY FOSSA (in mm.)	RANGE	
3 mos.	100	6.30	4.5	8.0	4.88	4.0	6.0
6 mos.	98	7.20	5.0	9.0	5.22	4.5	6.5
9 mos.	96	7.70	5.0	10.0	5.45	5.0	6.5
1 yr.	87	7.99	5.5	10.0	5.65	5.0	7.0
18 mos.	99	8.27	6.0	10.0	5.83	5.0	7.0
2 yrs.	97	8.46	6.0	10.0	6.01	5.0	7.5
30 mos.	88	8.64	6.0	10.5	6.12	5.0	7.5
3 yrs.	96	8.74	6.0	11.0	6.29	5.0	8.0
42 mos.	85	8.95	6.5	11.0	6.38	5.0	8.0
4 yrs.	97	9.04	6.5	11.0	6.42	5.0	8.0
54 mos.	83	9.17	7.0	11.0	6.47	5.0	8.0
5 yrs.	91	9.23	6.5	11.5	6.55	5.0	8.0
6 yrs.	93	9.41	6.5	12.0	6.68	5.0	8.0
7 yrs.	112	9.44	6.5	12.0	6.74	5.0	8.0
8 yrs.	120	9.52	6.5	12.0	6.80	5.0	8.5
9 yrs.	119	9.56	7.0	12.0	6.83	5.0	8.5
10 yrs.	145	9.65	7.0	12.0	6.84	5.0	9.0
11 yrs.	159	9.76	7.0	12.0	6.87	5.0	9.0
12 yrs.	159	10.03	7.0	12.5	6.96	5.0	9.0
13 yrs.	136	10.06	7.0	12.5	7.02	5.0	9.0
14 yrs.	117	10.18	7.0	12.5	7.26	5.0	9.0
15 yrs.	99	10.31	7.0	12.5	7.27	5.0	9.0
16 yrs.	94	10.37	7.0	13.0	7.31	5.0	10.0
17 yrs.	84	10.55	7.0	13.0	7.36	5.5	10.0
18 yrs.	70	10.66	7.0	14.0	7.41	5.5	10.0
19 yrs.	44	10.68	8.0	14.0	7.41	5.5	10.0
20 yrs.	33	10.70	8.0	15.0	7.42	5.5	10.0
21 yrs.	15	10.73	9.0	12.0	7.07	6.0	9.0
		Total examinations	2716				
		Total individuals	200				

This combination explains most of the variation in the total number of cases studied at each age, and a number of other factors account for the rest of the variation. In the very young an occasional film was

spoiled by movement. A child sometimes missed a scheduled examination due to illness in himself or in the family. A few families dropped out because of lack of interest or because of removal from the city. This study was in progress during the depression of the 1930's and

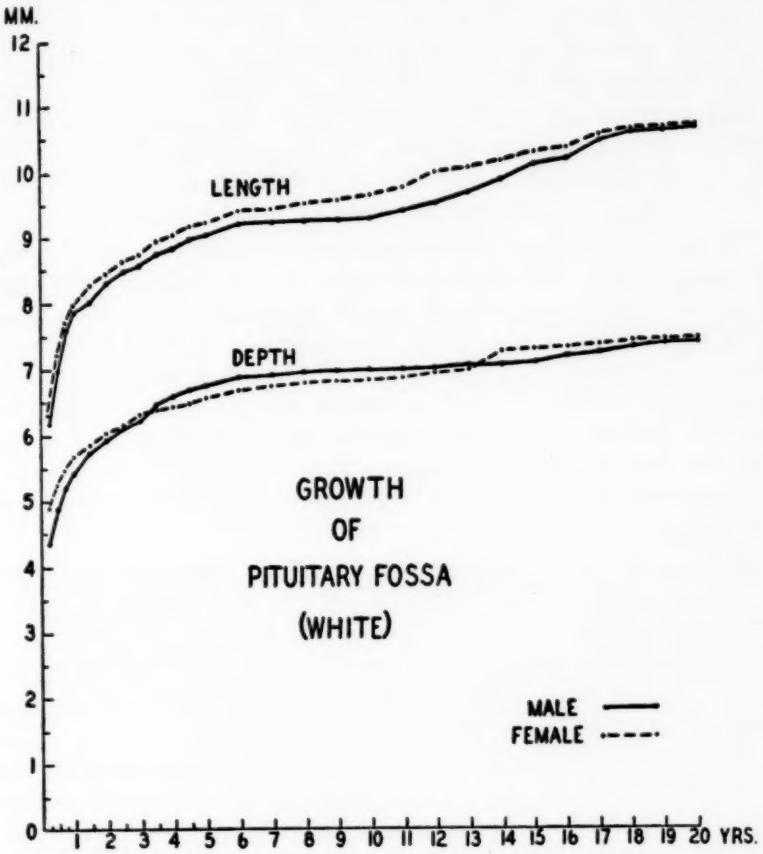

FIG. 1. GROWTH OF THE PITUITARY FOSSA IN MALE AND FEMALE WHITE CHILDREN FROM THE AGE OF THREE MONTHS TO TWENTY YEARS

during the second World War. Therefore some examinations had to be omitted despite the very excellent cooperation of the family.

The growth of the pituitary fossa in horizontal length and vertical depth recorded in Tables 5 and 6 is shown in Fig. 1 using chronologic age as the abscissa and length in millimeters as the ordinate.

The rapid growth in length of the fossa observed during the fetal period continues in each sex for some months after birth, but shows definite deceleration by the age of one year. Horizontal length is greater in girls than in boys from the age of nine months to eighteen years. The rate of increase in girls is quite uniform until the age of eleven years, then there is a preadolescent spurt seen at twelve years. During the next six years, growth is less vigorous but continues to the age of eighteen years when adult size is practically attained. In boys growth in the length of the pituitary fossa shows a more prolonged but less striking preadolescent spurt. By the age of eighteen years boys have caught up with girls and thereafter there is no sexual difference in horizontal length of the pituitary fossa.

The graph of increase in vertical depth shows no consistent sexual difference in rate. Growth in both sexes is rapid during the first year of life; thereafter, there is a less rapid but steady increase up to the age of eighteen years when adult dimensions are attained in girls. It is probable that in boys there is some increase in vertical depth up to the nineteenth birthday. At three months girls have deeper sellae than boys, but growth is more rapid in boys with the result that by four years the sella of boys is deeper. The girls again forge ahead at fourteen years, but by nineteen years the dimensions are the same in both sexes.

Rasmussen ('47), in a recent report on the growth of the hypophysis cerebri and its major subdivisions, shows that girls tend to have larger hypophyses than boys during the teens and that this sex difference is due to accelerated growth of the anterior lobe. These findings would indicate that the larger sellae seen in the girls in the early teens may be associated with accelerated growth of the hypophysis.

Gordon and Bell ('21, '23) have reported a roentgenographic study of the sella turcica in 104 normal children from the ages of one year to twelve years. They found a rapid increase in size during the first two years, and a gradual but irregular increase to twelve years. The girls had longer and deeper sellae. The number of cases in each age group was not great, and the findings for increase in depth are not as obvious as those for increase in length. Their results and those of the present paper show general agreement that during the growing period girls tend to have longer sellae than boys.

Camp ('24) made a study of 500 roentgenograms reported as roentgenographically negative and states the average length to be 1.60

cm. and average depth 0.81 cm. Kornblum ('32) gives 10 mm. as an average anteroposterior length, and 8 mm. as an average depth. These figures show good agreement with my average figures at eighteen years.

A study of Tables 5 and 6 shows that the range in length and depth is great. Extensive anthropometry was done on each child at each examination and there is no relation between the size of the sella turcica and other measurements. Very few of the children show any striking peculiarities of shape. In babies there are more shallow sellae than in later years. Gordon and Bell found in their series that the flat, or saucer-shaped, sella was practically limited to the first three years.

Gordon and Bell ('21, '23, '25, '26, '36) and Royster and Rodman ('22) agree that marked variations in size and shape of the sella occur, and that there is no reliable relationship between size and shape and function of the pituitary gland. The children in the present study show no evidence of pituitary disfunction, and the size of the fossa in individual cases bears no relation to general body size, proportions, or rate of growth.

GROWTH OF THE PITUITARY FOSSA IN LIVING NEGRO CHILDREN FROM THE AGES OF THREE MONTHS TO NINETEEN YEARS

Few of the Negro children were examined more than once. Therefore, this portion of the study is cross-sectional rather than longitudinal. From the Bolton files a group was selected containing a total of 139 male Negro children with a total of 212 examinations, and 252 female Negro children with a total of 271 examinations. All of the individuals gave evidence of satisfactory physical and mental progress. A great many displayed obvious racial admixture, and this part of the study is, in reality, one of a selected group of mixed racial stock.

Findings for the male Negroes are tabulated in Table 7, and for the females in Table 8. In Fig. 2 the findings for each sex are combined. The number of female individuals in age groups from ten to sixteen years inclusive is larger and, therefore, this portion of the graph is drawn in heavy lines. For purposes of comparison, the graph for males of the same age groups is likewise heavy, although the number of individuals at fifteen and sixteen years is small. Each of the age groups from three months to nine years, and from seventeen to nineteen years, has a small number of individuals, and, therefore, the

graphs are drawn with lighter lines. It is felt that no significant conclusions can be drawn from these latter two groups.

There is no clear-cut evidence of a preadolescent spurt of growth among the Negro children, but at the ages of twelve, thirteen, and

TABLE 7

Growth of the pituitary fossa in male Negro individuals from the age of three months to nineteen years

AGE	NUMBER OF INDIVIDUALS	AVERAGE LENGTH OF PITUITARY FOSSA (in mm.)	RANGE	AVERAGE DEPTH OF PITUITARY FOSSA (in mm.)	RANGE
3 mos.	1	8.00		4.00	
6 mos.	1	9.00		4.00	
9 mos.	1	9.00		4.00	
1 yr.	1	9.00		5.00	
2 yrs.	2	9.50	9.0 10.0	6.25	5.5 7.0
3 yrs.	4	8.75	7.0 10.0	6.88	6.5 8.0
4 yrs.	6	8.83	8.0 10.0	6.92	6.0 8.5
5 yrs.	7	9.14	8.0 11.0	7.57	6.5 8.5
6 yrs.	8	9.44	8.0 11.5	7.44	6.0 9.0
7 yrs.	11	9.32	6.0 12.0	7.41	5.0 9.0
8 yrs.	12	9.58	6.5 12.0	7.46	5.0 9.0
9 yrs.	12	9.50	8.5 12.0	7.59	6.5 9.0
10 yrs.	16	9.72	7.0 12.0	7.31	5.0 9.0
11 yrs.	25	9.94	7.0 12.0	7.46	6.0 10.0
12 yrs.	38	10.24	7.0 13.0	7.55	5.0 10.0
13 yrs.	38	9.84	7.0 13.0	7.46	5.0 9.0
14 yrs.	20	10.40	7.0 13.0	8.03	6.0 10.0
15 yrs.	3	11.00	10.0 12.0	8.33	8.0 9.0
16 yrs.	2	10.50	10.0 11.0	8.50	8.0 9.0
17 yrs.	2	11.00	10.0 12.0	9.00	9.0 9.0
18 yrs.	1	12.00		9.00	
19 yrs.	1	12.00		9.50	
		Total examinations 212			
		Total individuals 139			

fourteen years the girls do have slightly longer sellae than the boys. Since these age groups are fairly large, the findings may represent a true preadolescent sexual difference in rate of growth such as is seen in the white children.

The depth of the sella is definitely greater in the male Negro than in the female Negro and also greater than in either white sex. The very deep sella which I observed in Negro boys at fifteen years and older is not significant because I had very few individuals in each age

TABLE 8

Growth of the pituitary fossa in female Negro individuals from the age of three months to eighteen years

AGE	NUMBER OF INDIVIDUALS	AVERAGE LENGTH OF PITUITARY FOSSA (in mm.)	RANGE		AVERAGE DEPTH OF PITUITARY FOSSA (in mm.)	RANGE	
3 mos.	1	6.00			5.00		
6 mos.	1	7.00			5.00		
9 mos.	1	8.00			5.50		
1 yr.	1	8.00			6.00		
2 yrs.	2	8.50	8.0	9.0	6.25	6.0	6.5
3 yrs.	3	8.33	7.0	9.0	6.00	6.0	6.0
4 yrs.	4	8.50	7.0	9.0	6.00	6.0	6.0
5 yrs.	4	9.00	8.0	10.0	6.38	5.5	7.0
6 yrs.	4	9.25	8.0	10.0	6.50	5.0	8.0
7 yrs.	6	9.67	9.0	12.0	6.75	6.0	8.0
8 yrs.	4	9.75	9.0	11.0	6.25	6.0	7.0
9 yrs.	1	9.50			6.50		
10 yrs.	19	9.47	7.0	12.0	6.61	5.0	9.0
11 yrs.	41	9.85	7.0	13.0	6.96	5.0	9.0
12 yrs.	28	10.36	8.0	12.5	7.14	5.0	10.0
13 yrs.	53	10.21	8.0	12.0	7.18	5.0	10.5
14 yrs.	40	10.44	8.0	13.0	7.48	6.0	9.0
15 yrs.	32	10.73	9.0	14.0	7.27	5.0	9.0
16 yrs.	20	10.95	8.0	15.0	7.53	5.0	9.0
17 yrs.	4	10.75	10.0	12.0	7.63	6.0	9.0
18 yrs.	2	12.00	12.0	12.0	7.00	6.0	8.0
		Total examinations 271					
		Total individuals 252					

group. With a larger series of cases it is probable that the average depth would not be greater than 8 mm. The average depth of the sella in adult male Negro cadavera, as reported in the next section of this paper, is 7.63 mm. Royster, Rodman, and Moriarty ('22, '30), in a

study of the size of the sella turcica in white and colored males and females between the eighth and ninth years as measured on flat x-ray films, found the order of size was colored males first, white males

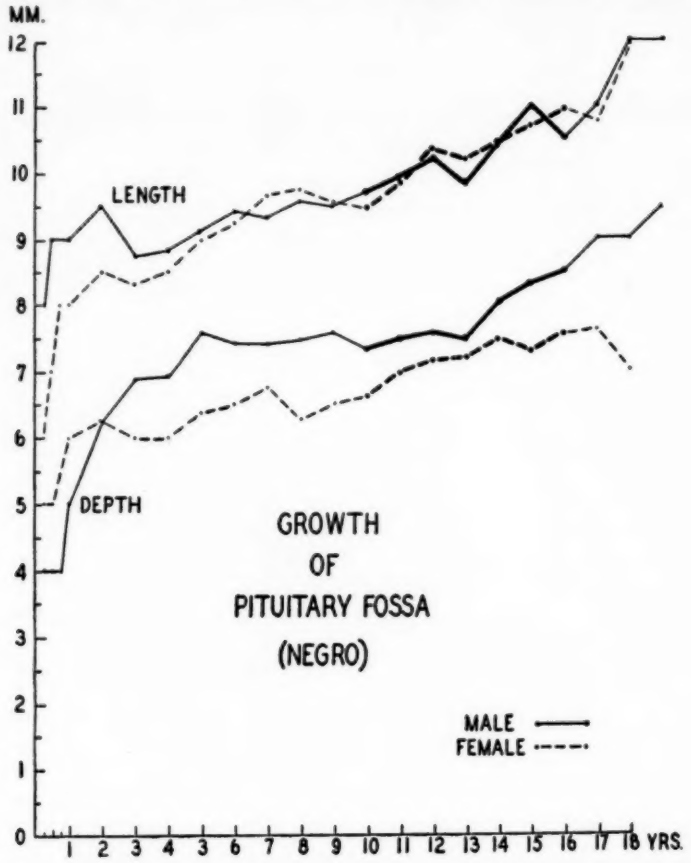

FIG. 2. GROWTH OF THE PITUITARY FOSSA IN MALE AND FEMALE NEGRO CHILDREN FROM THE AGE OF THREE MONTHS TO EIGHTEEN YEARS

Growth from ten to sixteen years inclusive is plotted in heavy lines because the number of cases in these age groups is greater and the findings are therefore more significant.

second, white females third, and colored females fourth, both for anteroposterior length and vertical depth. Although the present study has only a few colored individuals in this age range, there is exact

agreement for order of depth of the sella. In my series horizontal length is more in colored males than in white males. White females have longer sellae than white males. Since there are only four female Negroes at eight years and one at nine years, no conclusions can be drawn.

The range in size in the Negro is great, and once again there is no correlation between size of the pituitary fossa and general body dimensions or rate of growth. However, there are more sellae of unusual shape in the Negro and a greater tendency for the occurrence of massive clinoid shadows. These observations are in agreement with those of Royster and Moriarty who state they found white children to have a more regular and uniform contour, and that colored children show more very large and very small sellae.

DIMENSIONS OF THE PITUITARY FOSSA IN ADULT CADAVERA

From the documented collection of human skeletons of the Department of Anatomy of Western Reserve University, all skulls of three age groups, 25 to 35 years, 45 to 55 years, and 65 to 75 years, were selected for study. After damaged skulls were discarded, 1131 skulls of individuals of known age, sex, and color remained. Among the Negroes are included a very large number of persons with racial admixture. The pituitary fossae were examined and measurements of greatest horizontal length and vertical depth were secured. The records of those individuals whose skulls showed extreme measurements were checked. These records include full length and facial profile photographs, extensive anthropometry, and the complete skeleton of each person with notes on age changes and pathology, fluoroscopic findings, and dissecting-room notes. No individual with either an extremely large or an extremely small sella had a record of any gross abnormality which might be associated with pituitary disfunction. Measurements of pituitary fossae for the adult cadavera are summarized in Table 9. A study of this table shows no alteration in size with increasing age. Once adult dimensions have been attained, there are no further changes in size. The dimensions in the living white children at eighteen years are very close to those found in the adult white cadavera, and the findings indicate that growth of the pituitary fossa ceases at about that age.

In each age group the fossae of the Negro cadavera of both sexes are definitely longer than those of the white. In depth, all groups are nearly the same, but there is a slight tendency for the Negroes to

TABLE 9

Dimensions of the pituitary fossa in 1131 adult cadavera

AGE RANGE (in yrs.)	NUMBER OF INDIVIDUALS	LENGTH OF PITUITARY FOSSA (in mm.)	RANGE		DEPTH OF PITUITARY FOSSA (in mm.)	RANGE	
		White males					
25 to 35	84	10.82	8.0	16.0	7.64	5.0	11.0
45 to 55	331	10.59	7.0	14.0	7.60	4.0	10.0
65 to 75	181	10.65	7.0	14.0	7.42	5.0	12.0
	Total 596	Av. 10.68			Av. 7.55		
		White females					
25 to 35	25	10.32	8.0	13.0	7.78	6.0	11.0
45 to 55	40	10.46	8.0	13.0	7.59	6.0	10.0
65 to 75	26	10.29	7.0	12.0	7.38	6.0	8.0
	Total 91	Av. 10.37			Av. 7.58		
		Negro males					
25 to 35	153	12.01	8.0	15.0	7.64	5.0	11.0
45 to 55	147	12.13	8.0	17.0	7.63	5.0	17.0
65 to 75	30	12.20	10.0	15.0	7.55	6.0	11.0
	Total 330	Av. 12.08			Av. 7.63		
		Negro females					
25 to 35	55	12.05	10.0	16.0	7.89	5.0	11.0
45 to 55	42	12.18	9.0	16.0	7.94	6.0	12.0
65 to 75	17	12.21	10.0	18.0	7.65	6.0	12.0
	Total 114	Av. 12.12			Av. 7.87		

have somewhat deeper sellae. Among the living Negroes the number of older children is small, but there is a similar tendency for them to have longer and deeper sellae than the white children. Adult dimensions are probably attained at about the same age as in the white.

In both races and sexes there is a great range in size, but the fossae of the whites tended to be more uniform in shape, whereas the fossae of the Negroes showed more variability in form.

A number of investigators have worked on the dimensions of the pituitary fossa in adults, and Pruett ('28) has summarized the previous work in his paper. The only comparative studies of the dimensions in white and Negro are those of Hrdlička in 1898, Pruett in 1928, and Burrows, Cave, and Parbury in 1943. Hrdlička's work is based on the collection at Columbia University; Pruett's, on the collection at Washington University; and Burrows, Cave, and Parbury state that their white material came from a postmedieval London burial ground and

TABLE 10

Summary of reports on investigations of size of pituitary fossa

INVESTIGATOR	DATE	RACE	SEX	NUMBER	LENGTH	RANGE		DEPTH	RANGE	
Hrdlička	1898	W	M	30	11.1	7.5	14.5	9.1	6	12
		W	F	27	10.0	7.5	13.0	9.4	6	13
		N	M	9	10.9	8.5	12.5	9.3	6.5	11
		N	F	7	10.6	8	14	9.1	8	10
Pruett	1928	W	M	45	10.47	7	13.5	9.84	8	14
		W	F	11	10.45	8	16	10.27	9	12.5
		N	M	36	11.14	8.5	16	10.91	8	14
		N	F	7	11.14	8	13	9.86	8	14
Burrows, Cave, and Parbury	1943	W	M	30	11.05			7.49		
		W	F	5	10.79			6.98		
		N	M	20	11.18			7.18		
		N	F	14	10.17			6.79		
Present paper		W	M	596	10.68	7	16	7.55	4	12
		W	F	91	10.37	7	13	7.58	6	11
		N	M	330	12.08	8	17	7.63	5	17
		N	F	114	12.12	9	18	7.87	5	12

the Negroes were African from a known locality. Only Pruett's work is based on a documented collection comparable to the Western Reserve material. For purposes of comparison the findings of these four investigations and my own are summarized in Table 10.

There is excellent agreement between Pruett's findings and mine. We both find that the adult male white sella is slightly longer than

the female. Hrdlička and Burrows, Cave, and Parbury likewise make the same observation. Pruett and I find no sexual difference in length of the Negro sella, but the Negro sella is definitely longer in each sex than the white. My findings, based on a much larger collection than Pruett's, show an even greater racial difference than he found. Burrows, Cave, and Parbury found the male Negro sella to be the longest but in their small series the female Negro sella was the shortest.

In depth the Negro sella exceeds the white in my series, and the female Negro has the deepest sella. Pruett's male Negro sellae were the deepest, but he reports on only seven female Negro skulls. To secure vertical depth, Pruett roofed over the sella with a piece of sheet metal supporting it on the limbus sphenoidalis and the higher posterior clinoid process. From this sheet the greatest vertical distance to the floor of the fossa was measured. I used a different method, attempting to measure the vertical depth from the estimated location of the diaphragm to the floor. Therefore, my average figures for this dimension are less than Pruett's.

I wish to acknowledge the invaluable assistance of Dr. B. Holly Broadbent, Director of the Bolton Foundation, in making available to me the lateral roentgenograms which formed the basis for the study of the growth of the pituitary fossa in the living. These films, taken by the method he has devised with the Broadbent-Bolton roentgenographic cephalometer, enabled me to follow accurately growth changes over a long period of years. Dr. Broadbent's cooperation and interest made this portion of the study possible.

SUMMARY

1. A study of the growth of the pituitary fossa from the fifth fetal month to old age, based on human material of known age, sex, and color is presented.

A total of 418 fetal skulls, 400 living white children, 391 living Negro children, and 1131 adult skulls were studied. In all, a total of 7323 observations were recorded, of which 5774 were made on the living.

All of the individuals were free of any gross physical or mental defect in so far as a survey of extensive records could determine.

2. The pituitary fossa grows rapidly during the fetal period and during the first year of postnatal life. During childhood, growth is less rapid

but fairly uniform except for a brief preadolescent spurt. Adult dimensions are attained at about the eighteenth year.

3. During childhood the female sella is longer than the male, but in the adult the male sella is slightly longer.

4. There is no consistent sexual difference in depth of the sella in white children nor in adults. During childhood the male Negro sella tends to be deeper than the female. In the adult the female Negro sella is deeper than the male.

5. The Negro sella is longer and deeper than the white.

6. There is more variation in the shape of the Negro sella than of the white.

7. At birth the average horizontal length of the male white sella is 5.28 mm., of the female white 5.21 mm., of the male Negro 5.67 mm., of the female Negro 5.78 mm. The average horizontal length of the adult male white sella is 10.68 mm., of the female white 10.37 mm., of the male Negro 12.08 mm., and of the female Negro 12.12 mm. The average vertical depth of the male white sella is 7.55 mm., of the female white 7.58 mm., of the male Negro 7.63 mm., and of the female Negro 7.87 mm.

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CULTURAL ASPECTS OF BIRTH CONTROL IN PUERTO RICO

BY MARGUERITE N. KING

SOME two million people inhabit the Caribbean Island of Puerto Rico, smallest of the Greater Antilles. The population has doubled twice in the past one hundred years, and it is estimated that by 1960 Puerto Rico will have another million inhabitants unless a sharp reduction in the birth rate takes place.[1] Population density in 1940 was more than eight hundred per square mile of arable land as compared with slightly over two hundred in the United States.[2] The existing economic system with its strikingly uneven distribution of income, and the meager natural resources have proved incapable of adequately supporting this dense population, thereby condemning the majority to a near-starvation level of life. In 1941, for example, eighty per cent of all families achieved an average income of only $340.[3] Since living costs average much higher in Puerto Rico than in continental United States, the low family income makes the plight of the Puerto Rican even more desperate than these figures would ordinarily indicate.

There are no signs that a significant natural reduction in the rate of population growth will occur in the near future. Many Puerto Rican leaders hold that the basic problem is not one of overpopulation but rather of economics, and they forecast a diminution in the birth rate as the standard of living improves. This phenomenon has been observed in many parts of the world. Given sufficient time, such, in all probability, would be the case in Puerto Rico too. The time element, however, is crucial here. For unless population growth is stemmed immediately, any economic advances effected will be absorbed by the additional population, thus making impossible real improvement in the living standards

[1] F. P. Bartlett and B. Howell, *The Population Problem in Puerto Rico*, Technical Paper No. 2, Puerto Rico Planning, Urbanizing, and Zoning Board (Santurce, P. R., 1944), p. 4.

[2] J. E. Soltero, *El Camino de la Libertad* (Rio Piedras, P. R., 1946), p. 166.

[3] Bartlett and Howell, *op. cit.*, p. 11.

of the people as a whole. The trend at present, in fact, is for economic advances to lag behind the growth in population. Furthermore, it would be cruel to permit large numbers of Puerto Ricans to suffer starvation and disease while waiting for a doubtful economic factor to take effect. Although Puerto Rico's problem is basically economic, population control clearly ranks as an essential element in any program designed to better the living conditions of the inhabitants.

Since neither natural forces nor the economic factor can be depended upon to bring about the desired lowering of the birth rate—and perhaps of the population—two alternatives remain: large-scale emigration and the use of contraception. In the past emigration has been insignificant, only some sixty thousand persons having left the Island between 1910 and 1940.[4] There is no evidence to show that the heavy migration of the last few years, mainly to New York City, has appreciably affected the population situation on the Island. It must be concluded, therefore, that only a widespread birth control program provides the effective means to population limitation in Puerto Rico.

More than two-thirds of Puerto Rico's inhabitants live in rural communities, and this rural population boasts a fertility rate seventy-five per cent higher than the urban groups. Obviously, then, the rural people are most in need of family limitation. Whether the problem is viewed as fundamentally economic or populational, there is no doubt that overpopulation, or population pressure, exists in thousands of rural Puerto Rican households. The tiny, crude wooden shacks of one to three rooms which typify the rural home generally house from two to twelve or fifteen persons. Household equipment is reduced to a minimum, with many homes lacking such bare essentials as tables, chairs, closets, etc. Most primitive sanitary and cooking facilities are characteristic. Frequent illnesses, small stature, strikingly bad dental caries, and high death rates are some of the evil consequences of this life. Incomes are so low on the average that almost every cent earned must be spent on food, and these expenditures do not suffice to supply even a minimum healthy diet.

The municipality of Lajas, although rated among the better rural communities in Puerto Rico, nevertheless presents the typical problems of the Island with respect to population. This community of approximately fifteen thousand inhabitants is located in southwestern Puerto Rico and derives its chief subsistence from the cultivation of sugar

[4] Bartlett and Howell, *op. cit.*, p. 17.

cane. Broadly speaking, the inhabitants divide into three economic groupings: a handful of wealthy large landowners; a more numerous middle class comprising businessmen and owners of medium-sized farms; and the preponderant class of wage workers. Large families are found in all groups.[5]

According to the 1940 census, the ratio of children under five years of age to all women 15-44 years of age was 711 per 1,000 in Lajas, while the ratio for Puerto Rico as a whole was 652. In the same year the United States ratio was only 331. In 1940, Lajas officially recorded 583 births, including three pairs of twins. The 580 mothers had a combined total of 2,083 live children including the newborn, averaging 3.59 per woman. Four hundred and sixty-two children of these mothers had died, giving an average of 4.39 births per woman. Local records for 1940 showed that the average family in Lajas included 5.59 persons.[6] One hundred and seventy-one, or 29.5 per cent of the 580 mothers had five or more living children.

The data for Lajas clearly reveal an increase in family size as the age of the mother increases (see Table 1, and Fig. 1). This fact is most significant from the point of view of family limitation research. The group of mothers thirty years of age and over—133, or 22.9 per cent of the 580—had borne 972 children, an average of 7.30 each. Excluding their 199 dead children, these women averaged 5.8 living children. Finally, 90, or 67.8 per cent of them had five or more children living, including the newborn.

The physical drain on the mother of repeated pregnancies on a poor diet results in a high maternal death rate and a high infant mortality rate, higher in the rural than in the urban zones. In 1943, Lajas municipality recorded the highest maternal death rate on the Island, 133.3 per 10,000 total births. Although this was an exceptional year,

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[5] The data on Lajas were obtained during a two-months' field study, June-July, 1946, directed by Dr. Morris Siegel, Visiting Professor of Anthropology at the University of Puerto Rico, with the assistance of the writer. The research group consisted of four University social science students—Doris Diaz, Maria Ines Forastieri, Eugenio Fernandez, and Charles Rosario. Financial support for this study was provided by the University of Puerto Rico through its Social Science Research Center.

[6] The two parents are added to the number of living children to give the average family.

TABLE 1

*Number of births correlated with age of mother**

NUMBER OF BIRTHS	AGE OF MOTHER AT LAST BIRTH						
	Under 20	20-24	25-29	30-34	35-39	40-44	45-49
1	48	39	4	3	2	..	..
2	18	50	15	1	1	..	..
3	7	46	21	6	2	..	..
4	..	32	18	4	4	2	..
5	1	15	22	11	5	1	..
6	..	11	23	8	5	..	..
7	..	3	13	14	3	1	1
8	..	2	9	9	5	1	1
9	..	..	4	6	2	1	..
10	..	..	1	4	9	1	..
11	..	..	3	2	2	2	..
12	..	..	1	3	..	..	..
13	..	..	1	..	3	..	1
14	..	..	..	..	1	1	..
15	..	..	..	..	2	..	..
16	..	..	..	1	..	..	..
17	..	..	..	..	1	..	..
18	..	..	..	..	..	..	..
19	..	..	..	..	1	..	..
Total	74	198	135	72	48	10	3

* Data given only for the 540 mothers whose ages were recorded.

the rate of 61.6 in 1942 also stood out in Puerto Rican statistics.[7] In the latter year the rate for Puerto Rico was 41.7, as compared with the small United States rate of 5.4.[8] Infant mortality rates show the same dreadful picture. In Lajas, the infant mortality rate per 1,000 live births reached 120.8 in 1943, while that for Puerto Rico as a whole was 95.3. The United States had a rate of only 40.4 in the

[7] Government of Puerto Rico, Department of Health, *Report of the Commissioner of Health . . . 1943-1944*, p. 210.

[8] *Basic Statistics on Puerto Rico* (Ed., S. L. Descartes), Office of Puerto Rico (Washington, D. C., 1946), p. 15.

same year.[9] The contrasts between the United States and Puerto Rican maternal and infant death rates are indeed impressive.

The study of Lajas included one hundred households, representing all economic levels in the community. Detailed information on the subject of family limitation was obtained in forty-nine households,

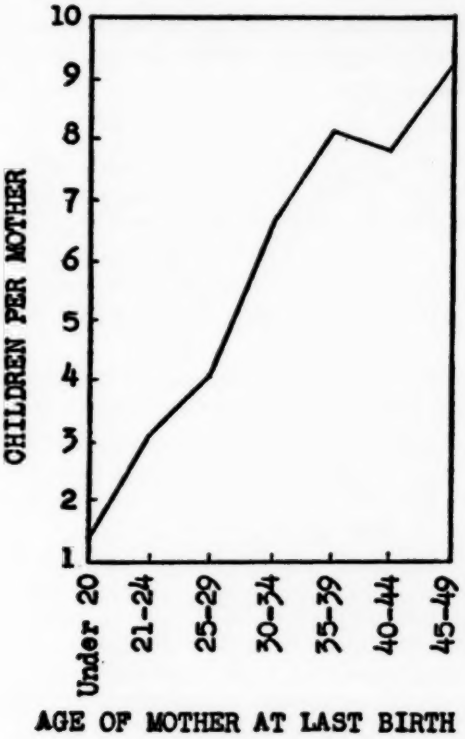

FIG. 1. CHILDREN PER MOTHER, BY AGE OF MOTHER AT LAST BIRTH

and the women revealed attitudes more or less generally held in the community. In addition, statements on the specific question of birth control were recorded for a large number of Lajeños, male and female, during the course of the study. It is worth noting here that the responses to birth control questions in other parts of the Island, includ-

[9] *Ibid*, p. 17.

ing the metropolitan center, San Juan, (obtained by the writer and the director of the Lajas study) fully support the findings in Lajas.

Almost unanimously, the women of Lajas and others questioned insisted that they would prefer to have fewer children. Only two among the sample of forty-nine women with whom birth control was intensively discussed declared themselves unwilling to limit their families. Ten women were somewhat vague in their answers, while the remaining thirty-seven expressed definite desires for family limitation. Th following thirteen cases demonstrate rather typical attitudes among Lajas women:

> Woman, age 25, 5 births, 4 children living and 1 stillborn. She does not know any method of birth control. She said, "If my husband would let me alone (meaning sexually), we could avoid children."
>
> Woman, age 35, 3 births, 2 living. She does not know any artificial method of contraception. She avoids sexual intercourse with her husband, which makes him angry. She has said to him: "Go look for another woman to have children."
>
> Woman, age 27, 3 births, 3 living. She had herself sterilized following the third birth. She said, "The poor should not have large families."
>
> Woman, age 17, no children. She is married to a man of 46 who has 7 children by a former marriage. She does not know any method of birth control. She does not want any children but if they come, she said, "I will just have to resign myself."
>
> Woman, age 24, 3 births, 3 living. Her husband wanted to have her sterilized, but he was warned that she was too weak to withstand the operation. She stated that she did not enjoy sex because of the consequences (meaning children). Her husband has declared that this sexual avoidance will be the cause of his leaving her. She is ashamed to go to the Lajas Public Health Unit for the contraceptive instruction that she knows is available there.
>
> Woman, age 71, 15 births, 10 living, 3 miscarriages. She said, "It would be better to have less children; the government ought to do something about it."
>
> Woman, age 22, 4 births, none living. She does not know anything of contraception, though she claimed that she was seeking the way to avoid more children. She stated that she went to the Public Health Unit, but they told her nothing. (Apparently she failed to make her wishes clear at the Unit.)
>
> Woman, age 22, 2 births, 2 living. She avoids sex relations with her husband to prevent pregnancies. She does not want any more children because "they cost a lot."

Woman, age 30, 8 births, 8 living. She said that she would like to be sterilized to avoid additional children, but she cannot afford the operation.

Woman, age 35, 2 births, 2 living. She does not know any artificial method of birth control. She said, "It is a crime to bring children into the world to suffer." If she had continued to have children, she claimed, she would have had herself sterilized.

Woman, age 40, 2 births, none living; 3 miscarriages with her second husband. She said that she separated from her first husband to avoid more pregnancies.

Woman, age 47, 7 births, 4 living. She avoided sexual intercourse to prevent conception. She told her husband to seek other women for sexual purposes because she did not want any more children. He finally left her to take up with another woman with whom he now lives in another village. She exhibited no resentment over his action, and spoke of him in the friendliest terms.

Woman, age 25, 4 births, 4 living. She has had 3 abortions. She does not know any contraceptive methods.

Knowledge of contraceptive methods was found to be extremely limited among the people of Lajas. It is probable that most men are aware of the use of condoms, but only five of the sample group of forty-nine women mentioned that they knew this method of contraception, and of these five only two reported using them. Methods known ranged from the modern techniques provided at the Lajas Public Health Service Unit to the most primitive magical practices. Sixteen of the women stated that they knew no way of avoiding children.

According to a local Public Health Unit report, four contraceptive methods are available to those seeking family limitation: condoms, foam powder and sponge, diaphragm and jelly, and Cooper Cream. At the time of the report (July, 1946), only the first three methods were in use among the twenty-seven active cases on the rolls of the clinic: twenty-two were using condoms; two, foam powder and sponge; and three, diaphragm and jelly. One hundred and fifty-one passive cases were on the records of the clinic; i. e., persons who had used one or another of the methods and had discontinued the practice. The main reasons given for discontinuance were (1) embarrassment, and (2) disapproval on the part of the husband.

The most drastic contraceptive method practised (or attempted) by Lajeños is total abstinence from sexual intercourse, referred to in this paper as "avoidance." This avoidance sometimes leads to the

separation of man and wife. Five of the forty-nine women informants asserted that they were practising avoidance to some extent; none of them gave evidence of knowing any artificial means of preventing conception.

A few individuals had heard of the natural rhythm method, but only one person claimed to practise it. The douche as a contraceptive technique was also mentioned, though no case of its use was found. The practice of withdrawal in sexual intercourse in order to avoid conception is apparently quite rare in this community, for only two women reported ever having resorted to this method. It may be noted in passing that the contraceptive usage of withdrawal has been described as a common practice in other areas of the world.

A single case of anal intercourse as a contraceptive technique was reported.

Sterilization of women is the best-known method of contraception in Lajas. All evidence indicates that it is equally popular throughout Puerto Rico, though the operation, for obvious reasons, may not be performed in a large number of cases. The widespread acceptance of such an extreme method in the Island contrasts sharply with American and European attitudes, which generally reject sterilization as a contraceptive technique. A combination of physical and cultural factors explains this special development among the Puerto Ricans.

Sterilization appears to offer many concrete advantages to the Islanders, particularly to the poor group. The operation is relatively inexpensive, costing between $60 and $80, or, when medically necessary, it may be obtained free. And when sterilization has been accomplished, the haunting fears of further pregnancies are at once eliminated. The embarrassment of repeated visits to a doctor, nurse, or druggist is also avoided. There is no longer the necessity for special preparation prior to intercourse with all the difficulties such preparation entails under cramped, crowded living conditions. Moreover, there is no chance of running out of supplies at the last minute or entirely forgetting or neglecting to use them. Finally, and most significant, there is no interference with sensation. This latter factor is vitally important in Puerto Rico and explains why sterilization is favored by the men. For this reason condoms are particularly disliked. The idea that contraceptives interfere with sexual sensation has become so deeply rooted in the minds of Island men that, regardless of the consequences,

many of them will neither use nor permit their wives to use any type of protection against conception.

Disadvantageous aspects of sterilization are apparently less obvious to Puerto Ricans. The undesirability of any unnecessary operation and the complete elimination of free choice with respect to having children are, of course, the most important objections. The large mass of poor, uneducated Islanders is probably unaware of the dangers that attend any operation, and will therefore tend to ignore this factor in sterilization. The question of free choice, although perhaps of moment to those with small families and the means to support more children, certainly is negligible among poverty stricken parents already overburdened with numerous children.

In Lajas, sterilization is said to be fairly common in the middle class and wealthy groups. Many poor women also look forward to this means of escape from large families. Five of the ten women from the sample of forty-nine, who spoke freely of sterilization, affirmed that they would undergo the operation if they found contraception necessary and if they could afford it. In many cases, individuals conceive the problem of having or not having additional children simply in terms of whether or not they can afford sterilization. Although the operation may be legally performed only when there are medical indications for it, this requirement rarely offers any difficulties. Among the poor, weakened as they are by a terribly inadequate diet from prenatal life on, physical conditions calling for sterilization almost always exist; the rich can usually make satisfactory arrangements.

The powerful impulse for sterilization rather than the less permanent methods of contraception may be seen in the following Lajas cases. A man talked his wife into having herself sterilized before they had any children. Despite his solid financial position as proprietor of a fairly large general store, he manifested profound fears of parenthood, saying that "a family brings suffering," and that "children create problems and additional economic worry." In another case, this time of a young veteran father of one child under two years of age, the wife was having herself sterilized in a nearby city the very day that her husband was being interviewed. He explained simply that he did not want to be burdened with a large family and, though he knew various techniques of contraception, sterilization was best because it involved no bother and was permanent. A third case of sterilization brought later regrets to the parents. The husband, owner of a good

business in Lajas, had persuaded his wife to sterilization after they had had two children. The operation took place several years ago at a time when they were facing financial difficulties. Subsequently, his economic condition improved considerably and along with this improvement a desire for more children arose. He stated most emphatically that both he and his wife now consider the sterilization a terrible mistake.

Puerto Rican ready acceptance of sterilization as a birth control method has provided a potent weapon to local anti-contraception forces. Official Catholic spokesmen and other propagandists against family limitation have made it a practice to identify "sterilization and contraception," as if both meant the same thing. In their attacks, whether on the radio or in the press, they link the two terms obviously to give the impression that birth control is a drastic, dangerous, and evil thing. The consistent stress on "sterilization and contraception" in their anti-birth-control fulminations, with the word "sterilization" always placed first, points clearly to the conclusion that it is a deliberate tactic.

The women of Lajas reported no effective contraceptive methods other than those mentioned above. They did, however, describe some irrational techniques which deserve noting since they reveal a deep ignorance of birth control from a physiological standpoint. One woman said that, prior to menstruation, she took quinine pills, for which she paid ten cents each at a pharmacy. Other women told of the use of (unspecified) herbs and purgatives, probably aimed at inducing an early abortion. Two women, finally, claimed that post-intercourse urination prevented conception; one variation of this technique required three sips of water before intercourse as well.

Many reasons may be cited to explain why effective contraceptive measures have not been adopted in Lajas in the face of a widespread desire for smaller families and the availability of clinical services. The principal obstacles arise from the physical conditions in which the majority live, from cultural and psychological factors, and from the direct opposition of the Catholic Church. It is most probable that the same reasons apply as well to Puerto Rico as a whole.

In almost every poor household parents and children share the same room; frequently one or more children sleep in the same bed with the parents. Sexual intercourse, therefore, must be performed quietly and with as little bother as possible. The use of a contraceptive, particularly one which requires special equipment or a complicated procedure, presents difficulties. Inadequate sanitary facilities further

complicate the situation. Few families have bathrooms within the home; a latrine in the yard serves the large part of the population, while some households have no facilities whatever. The scarcity of water in this area makes even elementary cleanliness a problem, for the municipality provides water only twice daily, each time for an hour or two. A great many persons depend entirely on community pumps or faucets, while those living some distance from the center of the municipality must haul their water long distances.

The factor of distance plays a more direct part in connection with contraception. Much of Lajas' population lives far from the town, where the clinic and drugstores are located. Hence visits and purchases are made infrequently, especially since the trip via public vehicle costs up to fifty cents. Such expenditures are important for families earning $10 a week or less. The time necessary for special visits, during which children must be left with neighbors or on their own, cannot always be taken by women already overburdened with household chores. Location of house acts, therefore, as an inhibiting influence even when a strong desire for contraception is present in the individuals.

Education, experience, embarrassment, fear, and confidence constitute some of the cultural and psychological factors influencing the spread and usage of contraception.

Puerto Rico's poor peasants and agricultural workers typically enjoy only a few years of inferior schooling. In the rural parts of Lajas, for example, educational facilities extend through the third grade, with further schooling available in the town center or at other great distances from most homes. Consequently, vast numbers of ruralites are illiterate or semi-illiterate, and almost totally cut off from the main current of world events. This inexperienced, ignorant people patently lacks the sophistication prerequisite to an immediate and intelligent acceptance of birth control. Many, in fact, have never even heard of it, particularly women whose lives are circumscribed by the traditional *kinder, kirche,* and *küche.* And among those who know of birth control, there are few who have ever used the techniques.

Major obstacles to a wide adoption of contraceptive practices in Lajas (and in Puerto Rico) rise from personal embarrassment and shame relating to sexual subjects. This is true of men and women alike. Sex and birth control are not discussed freely among Lajeños either of the same sex or of opposite sex. The feeling of shame, almost a cultural pathology, usually taboos such subjects even between man and

wife. Visits to the clinic are not easily initiated for fear that neighbors may think that venereal disease treatments are being taken.[10] A number of women expressed horror at the prospect of being subjected to a vaginal examination, particularly by a male physician. This reason alone is sufficient to prevent a woman from securing the desired contraceptive information. Moreover, the embarrassment that keeps a woman (or a man) from making the initial visit to the birth control clinic also inhibits further visits for supplies.

Lajas women have extremely few contacts with doctors, depending almost entirely on local, poorly-qualified *practicantes* for medical advice and treatment, and upon midwives for childbirth. During the five year period 1941-45, the municipality registered 2956 births, including twenty-one pairs of twins. Only ten of these births took place in the municipal hospital or with the aid of a medical doctor. It is not surprising, therefore, that so many Lajeños shy away from the physician's examination legally required in advance of the instruction in birth control techniques. As a matter of fact, several women declared that they preferred a midwife, even though inadequately trained, to a male doctor whose services might be obtained free of charge, specifically because of shame at being seen by a man.

Many strange ideas and prejudices about contraception are current among these people. They have heard that it is "bad" to go to the clinic, the word "bad" meaning different things to different persons. Some reported that contraceptive methods are painful, dangerous, or ineffective. The symptoms of pain and burning mentioned have some basis in fact and deserve careful investigation.[11] In many cases, however, the complained-about discomfort may be largely imaginary, caused by fear or used as a cover-up for other objections, such as the husband's disapproval of contraceptive usage. A number of women told of failures occurring in spite of the use of Public Health Service methods. Whether these reported failures were the fault of the contraceptives or the users is not as important as the effect of the reports on potential applicants for birth control. Failures, of course, breed lack of confidence among the people, and without full confidence in the effectiveness of the techniques, the whole birth control program soon bogs down.

[10] Many Lajeños stated this.

[11] For the same complaints, see G. W. Beebe and J. S. Belaval, "Fertility and Contraception in Puerto Rico," *The Puerto Rico Journal of Public Health and Tropical Medicine*, Sept. 1942, pp. 31-33.

With respect to the use of condoms, a special attitude on the part of many men serves to frustrate this type of contraception. Condoms are associated in their minds with prostitution; it is not a method one uses with one's wife.

Although the Catholic Church has taken an intransigent position against all forms of birth control except, of late, the so-called natural rhythm method, it does not appear that the Church is an important deterrent in the minds of Lajeños. Among the sample of forty-nine women only one mentioned the religious aspect. She was one of the few regular contraceptors, but said that she felt guilty about the practice and would not, of course, tell her priest. Two persons expressed the belief that "children are the will of God."

As long as birth control remains limited in Puerto Rico, the Church will probably maintain a hands-off attitude. But if an intensive contraception program is instituted, it is more than likely that the Church will go into action. According to many trustworthy informants throughout the Island, during a former large-scale attempt to disseminate birth control information, Catholic priests went from house to house warning the people that contraception is a sin and that it would be punished if practised. Their campaign was quite successful. The same direct tactic will probably be tried again if the need arises.

The Lajas data indicate that the Catholic Church is not a vital force in this community, especially among the poor. Although most individuals are nominally Catholics, the actual number of practising members of the Church is rather small. A substantial group has broken away from Catholicism and taken up with the Presbyterians, the Pentecostals, or the Seventh-Day Adventists. In addition, a considerable group devotes itself to *Espiritismo,* a brand of Spiritualism that is increasingly gripping the Puerto Rican people. *Espiritismo* is gradually developing into a full-fledged religion. Thus the small community of Lajas, with its fifteen thousand inhabitants, practises four—perhaps five—different religions. Nevertheless, despite the Catholic Church's apparently weak hold on the people of Puerto Rico, its influence with respect to a birth control program should not be discounted. For in many minds there still remains a background of superstitious beliefs and fears which the Church could readily turn to its advantage in an attack on contraception.

CONCLUSION

It is clear that population control is vitally and immediately necessary in Puerto Rico. Since neither economic development nor emigration can be depended upon to bring about the essential reduction in the birth rate, the sole alternative left is a widespread and intensive birth control program.

In addition to the general population problem in Puerto Rico, there is the more pressing problem of overpopulation within individual households. This has been caused by the combination of poverty and large families. Living conditions are, consequently, so bad for the majority of the people that many otherwise avoidable health problems prevail.

The evidence from Lajas illustrates the Island's high maternal and infant mortality rates, the increase in family size along with the age of the mother, and a profound ignorance among the population on the subject of birth control, in the face of a general desire for family limitation. The strong emphasis on sterilization is to some extent indicative of the lack of knowledge of less drastic contraceptive techniques.

The most significant obstacles hindering a wide adoption of birth control derive from the basic living conditions of the people, cultural factors, and a variety of inhibiting psychological attitudes.

The Catholic Church, although it does not seem to be much of a force in the community, nevertheless continues as a potential source of interference in any widespread birth control program.

The above facts suggest some minimal requirements for the effective implementation of any plan to limit population growth in Puerto Rico. A thorough educational program, designed to reach men as well as women, seems fundamental in combating the cultural and psychological resistances that at present impede the acceptance of contraception. It should be kept in mind that the Puerto Rican culture, as a result of its Spanish heritage, still stresses the dominant rôle of the male, and unless the willing cooperation of husbands is secured even the most carefully formulated campaign may break down.

Since the physical environment in which Puerto Ricans live approximates the primitive, it is essential that specific contraceptive techniques be recommended only on the basis of thorough knowledge of home conditions. Visits to the homes should therefore form part of a birth control program. Obviously it is useless to prescribe a technique which is doomed to failure from the start by reason of its impracticability in

the home situation. Beebe and Belaval have emphasized a similar point, saying that "So long as the clinician must limit his advice to the methods currently available, he must accept the fact that all present methods give the patient control over her own destiny, and that what she herself will do may be more important than the specific method advised. Once this is appreciated, all characteristics of methods which enhance the likelihood of their acceptance and sedulous use, will be recognized as important for the protection of the patient." [12]

The major difficulty involved in getting patients to the clinic for initial examination and instruction can be reduced considerably by the employment of female rather than male physicians. The factor of embarrassment, in the opinion of the present writer, cannot be overestimated in dealing with unsophisticated Puerto Ricans.[13]

Although seemingly anxious to limit their families, the people of Puerto Rico have not yet reached the point where they are willing to adopt birth control practices which entail personal sacrifices. In order to insure the success of a program, it is therefore imperative that as many barriers as possible be disposed of in advance.

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[12] G. W. Beebe and J. S. Belaval, *op. cit.*, p. 49.

[13] The intensity of embarrassment among Lajas women about intimate personal matters is strikingly demonstrated by the fact that some of them said they did not like to be seen pregnant because people would know that they had had sexual intercourse.

A CICATRIX OF THE NECK ASSOCIATED WITH ANOMALOUS DENTAL OCCLUSION IN ONE OF A PAIR OF MONOZYGOUS TWINS

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CO-TWIN CONTROL METHOD

THE co-twin control method has special advantages in the study of a wide variety of problems. Monozygous (one-egg) twins have identical hereditary potential and, especially in man, where experimental procedures can rarely be applied, one twin of such a pair serves well as control for the study of any one of a variety of influences which have affected his partner. Gardner and Newman (1) exploited this property in their classic study of identical twins reared apart.

The number and variety of environmental influences which may affect men, even twins gestated in the same uterus and reared in the same home, are so complex, however, that even among one-egg twins there are frequent differences in anatomic traits as well as in psychological capacities. The incidence of such discordances in one-egg twins may be used as a measure of the "penetrance" of the genotype (2, 3). Estimates of penetrance may be even more accurately approximated when the incidence of discordance in dizygous (also called two-egg or fraternal) twins is compared with that in monozygous twins. Such a concept of "penetrance" is, however, a statistical abstraction. It represents a kind of average tendency for a certain genotype to be expressed in the phenotype under a wide variety of environmental conditions. More important to the human biologist is the knowledge of the specific kinds of environmental influences which determine how the hereditary tendencies, the genotypes, will express themselves outwardly in the phenotypes.

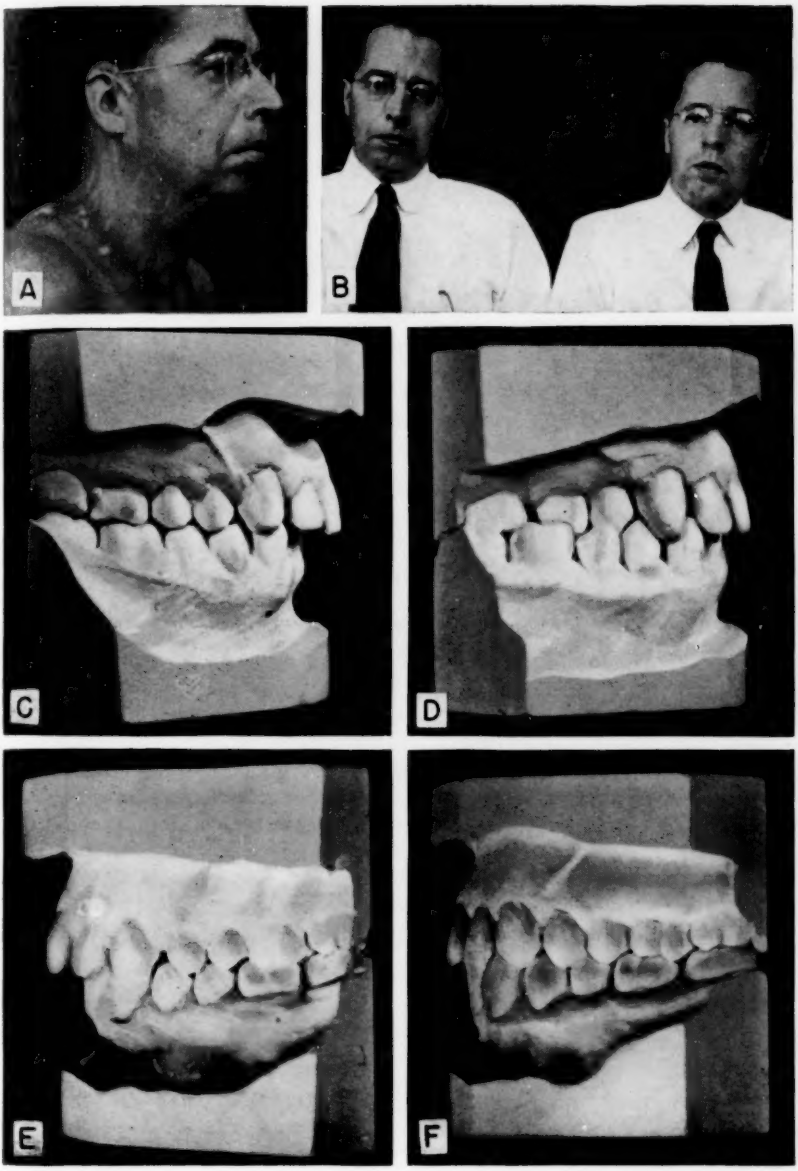

Fig. 1A. The Burn Scar of R. A. B. R. A., Left; H. A., Right, Showing Similarity in Appearance. C. Right Side of Dental Casts of R. A. D. Right Side of Dental Casts of H. A. E. Left Side of Dental Casts of R. A. F. Left Side of Dental Casts of H. A.

The aim of investigations of human biology is to elucidate specific functions between one event and another. Causal relationships are often evident where the changes are radical. However, where the recorded changes are small in terms of the variability of the trait in question, there is need for more carefully controlled observations. Here twin studies offer much to the solution of some problems. A careful investigation of the particular life histories of twins might reveal the specific causes of a discordance. Such a functional relationship may exist between the contracture of the neck caused by a burn scar and the malocclusion observed in one of the pair of twins here reported. The observations of the association of the anomalies of the bite in the same individual with the scar leads us to investigate: first, the nature of the cicatrix; second, the nature of the occlusion and the differences between the twins in this respect; third, whether the twins are monozygous or dizygous; and fourth, to speculate on how such a mechanical stress as a contracture might affect the form of the jaws.

CICATRIX

R. A., a physician, aged 35, was severely burned by molten lard when a child. He provides the following account of a burn on the right side of his face and of the scar:

> I was burned at the age of four (1915). The burned area extended from mid-line of neck anteriorly to a line extending vertically through external auditory meatus down to clavicle. The pre-auricular region of face was also burned. All these burns were of third-degree type and healed with a heavy cicatrix. In my younger days the pull exerted by the cicatrix was quite constant. Today rotation of head to the left and extension of head will cause a cord to stretch from clavicle to submental scar and interfere with those movements.

Fig. 1A shows the wide extent of the scar covering the greater part of the right side of the neck. It will be noted that even in the resting position there is some tension of the cicatrix, and that the direction of pull of the contracture on the chin is backward and somewhat downward and laterally to the right. There has been no plastic surgery and no orthodontic treatment.

DENTAL OBSERVATIONS

Figs. 1C and 1E show the dental occlusion of R. A. It will be seen that between the upper and lower first molars of either side there is virtually a normal relationship, but that there is some measure of

bimaxillary protrusion, i. e., relative prognathism of the upper incisors. There is some asymmetry, the lower jaw being deviated to the right. The palate is rather narrow, and there is no palatine torus except perhaps a faint trace of a ridge posteriorly. The upper third molars are lost, and the lower third molars are apparently impacted. The other lower molars, the upper first molars and the upper left first incisor and canine have been filled. There are small diastemata between the upper canines and the lateral incisors.

H. A., the co-twin, also is a physician. Except for his lack of the scar, he looks very much like his brother. Figs. 1D and 1F show the dental occlusion of H. A. The lower left third molar was extracted because of impaction. It will be seen that the upper right first molar also is missing. There is consequently marked asymmetry. The mandible is deviated to the right—even more so than in R. A.—and the posterior maxillary teeth bite lingually to the mandibular ones on that side. The loss of the first molar complicates the situation, but it is clear that there is less relative anterior jut of the maxilla and less vertical overbite than in the other twin. The palate is also narrow, and there is no palatine torus. The teeth are similar to those of his twin. All remaining first and second molars, the upper left premolars and the upper left first incisor have been filled. The lower right third molar is unerupted but is said to be present in the jaw. Diastemata exist between the upper canine and incisors on the right side, the side with the missing molar.

MEASUREMENTS

There is relatively little difference in size between the twins. The following measurements were taken on the subjects, with sliding calipers:

	R. A.	H. A.
Total facial height	129 mm.	126 mm.
Upper facial height	80	78.5
Nose height	58.5	55
Nose breadth	34.5	35
Bigonial breadth	109	108
Minimum frontal breadth	110	109
Interocular breadth	33.5	33

The following measurements were taken on the casts:

	R. A.	H. A.
Left upper 1st incisor width	8.3 mm.	8.4 mm.
Right upper 1st incisor width	8.3	8.4
Left upper 2nd incisor width	7.3	6.9
Right upper 2nd incisor width	6.9	6.6
Left upper canine width	8.4	8.2
Right upper canine width	8.0	8.1
Left lower 1st incisor width	5.2	5.3
Right lower 1st incisor width	5.2	5.3
Left lower 2nd incisor width	5.7	5.9
Right lower 2nd incisor width	5.7	5.9
Left lower canine width	7.2	7.2
Right lower canine width	7.2	7.3
Upper intercanine width	36.1	36.9
Lower intercanine width	27.3	25.8
Upper palate width between 1st molars	43.0	...
Mandibular width between 1st molars	38.6	42.6

It will be seen that R. A. has a slightly longer face but that this represents a difference in the nasal portion rather than the jaws. If anything, R. A. is also slightly larger in facial breadths. Both twins have the same stature: R. A., 1751 mm.; and H. A., 1752 mm. In tooth size the twins are similar. Differences in mandibular width appear to be related to the missing upper first molar in H. A. There is also some difference in lower intercanine width.

RESEMBLANCES

The general resemblance of the twins is very close (see Fig. 1B). Hair color is the same in both individuals, and the amount of hair on the arm is similar. There is a slight difference in the forehead hair line. The eyes are the same in color, and the form of the ears is similar. The shape of the nose is very similar, and so is the form of the chin. The shape and size of the hands are similar. The general appearance is that of identical twins.

Several details of the teeth also show similarities. Besides the tendency in both to impacting of lower third molar teeth, neither shows Carabelli's cusp. Both have a trace of a tendency towards shovel-shaped incisors, both have teeth of similar size, the dental arches and palate are roughly similar in shape, and both twins lack mandibular tori and alveolar hyperostoses.

R. A. is right-handed. H. A., however, deals cards with his left hand and says that when very young he also threw a ball with his left hand.

The twins indicate similar taste responses to paper impregnated with phenyl-thio-carbamide (P.T.C.) According to R. A., the taste is similar to chloroform (presumably somewhat sweet). H. A. at first said that the taste is sweetish like acetone but he later added that it is a little bitter.

SEROLOGY

Both twins belong to the same blood types and groups. Dr. Wolf W. Zuelzer of the Department of Laboratories, Children's Hospital of Michigan, Detroit, has very kindly examined both twins in this respect. He reports that both are type B, both are M, and both are Rh positive of the type Rh_1Rh_2 (CDE). Both are positive to 85 per cent (anti D) serum, both are positive to 70 per cent (anti C) serum, both are positive to 30 per cent (anti E) serum, and both are positive to Hr′ (anti F) serum. These findings are, of course, consistent with the probability that the twins are monozygous.

DERMATOGLYPHICS

Finger and palm prints were made. Dr. Harold Cummins of the Department of Anatomy at Tulane University School of Medicine, New Orleans, kindly analyzed them. He reports:

> In this case the chances are much in favor of single-ovum origin. The chief dissimilarity is in the index fingers of the left hands, which bear patterns of widely different type and ridge count. The weight of this difference, however, is lessened by the fact that the index is more labile genetically than other digits.

Cummins' table listing the formulae and quantitative determinations follows (see Table 1). It will be seen that the inter-twin differences are no greater than between right and left hands of the same individual.

DISCUSSION

In several previous studies it has been shown that, although one-egg twins tend to be concordant in respect to dental occlusion, this is not always the case. In 1924, Siemens and Hunold (4, p. 420)

TABLE 1

Comparison of dermatoglyphics of the twins

	R. A.		H. A.	
	Right	Left	Right	Left
Palmar main lines	11.9(10).7(8).5″–t	9(10).9.5″(6).5′–t	11.9.7.5′–t	11(10).9.7(6).5′–t
Palmar patterns	A^u. O. V. L. M.	A^u. O. M. L. V.	A^u. O. V. L. M.	A^u. O. M. l. V.
Finger patterns, types	U U U U U	U IP U U U	U U U U U	U A U U U
Finger patterns, counts	21 11 12 14 11	18 17± 4 14 16	20 13 8 19 6	17 0 1 15 16
Finger Total counts	69	69	66	49
Finger Total counts	138		115	

wrote that in the cases of anomalies of the bite examined by them, non-hereditary factors have played a really essential role.

In 1928 Siemens (5) summarized the results of several studies covering approximately 151 pairs of monozygous twins and 160 pairs of dizygous twins. In 10 (plus 3 doubtful) pairs of the former, both twins showed similar anomalies of bite in the mesiodistal direction, while in 9 pairs only one twin showed the anomaly. Among the two-egg twins, however, only one (plus 2 doubtful) pair showed positive concordance, while 22 pairs were discordant.

In respect to vertical bite, Siemens (5, p. 1749) says that in contrast to the mesiodistal anomalies of bite, the vertico-frontal ones in his material show themselves almost purely genetically limited (among one-egg twins almost entirely concordant, whereas among two-egg twins preponderantly discordant). Among uniovular twins he cites 8 (plus 4 doubtful) pairs with positive concordance of open bite, deep bite or frontal crossbite; he found no instances of discordance. Among the dizygous twins, however, he cites only four cases of positive concordance and 13 cases (11 of them frontal crossbite) in which anomalies occur in one twin only.

Siemens reports the Angle type II occlusion to be discordant in 13 pairs of dizygous twins and concordant in but one pair (plus 2 others doubtful). Among the monozygous twins, on the other hand, he reports 8 instances (plus possibly 3 others) where both twins show the trait, and 6 pairs in which only one twin presents the characteristic. It is interesting to note that to one of these last, Siemens appends as a note the one word, "Trauma." It would certainly be of value to know what kind of trauma was thought to be responsible. One also wonders what difference in the circumstances might have affected the other discordant pairs of monozygous twins.

In a report on the dental characters of twins, 3 to 14 years old, Bachrach and Young (6, p. 1302) say:

> It is interesting to record that in practically all cases, where more or less distinct irregularity of the teeth and arches was observed in one twin of the identical type, a similar defect was observed in the other twin of the pair.

Among 107 pairs of identical twins and 132 pairs of fraternal twins 51.5 per cent of the former and 26.2 per cent of the latter were discordant.

Similarly Zeiger (7, p. 142) says that among one-egg twins one finds many with similar development of anomalies of the dental occlusion but that among two-egg twins this is rare.

Nine other pairs of young adult identical twins examined by one of us (G.W.L.) during the last four years showed various degrees of concordance in dental occlusion. All these individuals were probably more similar to their twins in this respect than is the pair here reported.

The evidence from general appearance, details of pigmentation, teeth and hair, blood groups and types, and finger and palm prints make it highly probable that H.A. and R.A. are one-egg—so-called "identical"—twins. The differences in the dental occlusion between them therefore cannot be ascribed to a genetic difference. They must be ascribed to some factor or factors in the experience of the individuals, as must also the previously reported instances of such discordances.

As the affected twin has a contracture of the neck of long standing, the question arises whether this could have had a mechanical effect on the form of the jaws. Many persons have speculated on the possible effects of a wide variety of mechanical influences, and some experimental evidence exists. Thus Washburn (8) cites evidence to indicate that the normal pull of the masseter muscle is a factor in moulding the shape of the face in rats. Similarly he has shown in another study (9) that even the small muscles of expression have a similar influence on facial bones: both rats and rabbits show marked asymmetries after paralysis of these muscles.

From analogy with the experimental evidence it would seem likely that burn scars also may have an effect on the development of the face. A mechanical traction of long standing would, however, operate in the opposite direction from a paralyzed muscle. In discussing contractures, Webster (10, p. 936) says:

> Scar tissue contractures may limit the growth of bone if present in the growing child. The forces of development are restrained by these nonelastic bands, and atrophy of disuse adds to the deformity. It is essential for normal growth that these contractures in growing children be released as early as possible. A poorly developed mandible, for instance, may result from contracting scars about the neck.

Similarly, Davis (11, p. 622) writes:

> In burn contractures of the neck, chest and chin, the shape of the mandible is often distorted, and the full development of the bone is checked by scar pressure. The alveolar process is frequently turned outward and the teeth forward and even downward in severe cases.

A pertinent case is described by Howes (12, p. 1141):

> The patient was a girl twelve years old who at the age of four years had suffered a severe burn from a gasoline stove. The contracture of the scar tissue about the lower part of the face and neck had drawn the anterior part of the mandible downward and forward, carrying the teeth with it. The influence of this force is seen even in the molar regions; on the right side the mandibular first molar was definitely forward of its normal relation with the maxillary first molar, while on the left side both maxillary and mandibular molars had drifted downward, which accounts for the squeezing out of the maxillary left second premolar. Both arches were narrow because of the contracture of the scar tissue on the face.

The causal relationship between the burn scar and the anomalous dental occlusion in the instances cited is merely inferred and could not be traced were the changes less pronounced. In the present case no such radical changes occurred, but it seems likely that smaller changes, represented by the differences noted between the twins, have a similar explanation. The type of change is different from that in Howes' case, but this one might expect because of the difference in direction of the pull of the contracture.

One of the difficulties in interpreting the direct effect of the burn scar is that the twin brother also has an anomalous dental occlusion. In the latter case one of the chief causes is probably the early loss of an upper first molar. But it should be noted that the general asymmetry of the jaws takes a similar form in both twins. Furthermore, the co-twin shows some slight tendency to the same type of malocclusion, so at most one can ascribe to the burn scar only the full expression of a tendency probably already present. In the absence of satisfactory data on the facial growth one can merely call attention to the fact that there is no evidence that the affected twin has an absolute retardation of jaw growth. Compared with those of his brother, his jaws are somewhat wider (bigonial diameter), approximately as deep, and approximately as long.

SUMMARY AND CONCLUSIONS

1. The present study exemplifies the use of known histories in monozygous twins to elucidate functional causal relationships in problems of human biology.

2. A pair of twins were examined and shown to be monozygous by a number of criteria: (a) the general appearance, pigmentation,

hair, and details of facial morphology are similar; (b) several details of the teeth are similar; (c) taste reactions to P.T.C. are similar; (d) the ABO, MN and Rh subtype serological reactions are identical; and (e) the analysis of finger and palm dermatoglyphics points to the probability of monozygosity.

3. One twin has a bimaxillary protrusion involving upper incisor jut and deep bite. This twin has had a burn scar of the neck since the age of four with a cicatrix which probably has exerted a mechanical backward and somewhat downward and outward pull on the mandible for 31 years.

4. The co-twin lacks the malocclusion though having some tendency in the same direction. Associated with a missing upper first molar, the remaining upper molars and premolars of the same side have lingual relationship to the lower molars, producing an asymmetry even greater than in the burned twin.

5. Though factors affecting the co-twin make a simple functional explanation hazardous, a likely inference is that the contracture of the scar caused a relative underdevelopment of the mandible. It must be noted, however, that: (a) there is no evidence for an absolute underdevelopment; (b) that the lateral displacement is less than in the co-twin (where loss of an upper molar may have played a part); and (c) that the anomalous form of the occlusion merely manifests a more marked type of a tendency also noticeable in the co-twin.

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